SCREENING APPARATUS

This invention relates to screening apparatus. In particular the invention relates to vibratory screening apparatus including a polymeric screening panel, screening modules for use in such screening apparatus, and methods for their connection, and for illustrative purposes reference will be made to this application. However it is envisages that this invention or elements of it may find application in other screening applications such as fixing rigid screen panels to a support frame of such an apparatus, and in stretched screen apparatus.

In the art of vibratory screening apparatus, there are advantages in the use of polymeric screening members. Certain polymers such as polyurethanes may be used in lieu of fabricated metal screens in cases where the superior resistance to abrasive wear possessed of polyurethane is an advantage. Polyurethane screening members may be cast in a wider variety of forms with ease as opposed to the limitations in fabricating metal screens. Most polyurethane screening members incorporate edge and intermediate reinforcing of steel or other reinforcing to rigidly support the screen surface thereon. Screens made entirely of plastic (usually polyurethane) have also been suggested. Such screens are able to be recycled when worn and the raw material from which they were manufactured was able to be re-used. Plastic screens by their very nature are flexible and unless adequately supported and mounted in the apparatus are able to flex. When the screens are allowed to flex excessively the openings through the screen become distorted and the screen allows larger particles than intended to pass through the screen, or fails to grade to a sharp cut-off on particle size.

Australian Patent Specification 21009/83 (FIORIS PTY LIMITED) discloses a variety of screen member constructions comprising screen member modules, most having steel reinforced edge portions. The modules are adapted to be assembled in multiples to a support structure, adjacent modules abutting with complementary halves of a bead arrangement adapted to engage a profiled support bar which retains the modules in relative location. In one embodiment, best illustrated in Fig. 7, there is provided an unreinforced screen panel adapted to snap into a stiffening grid of support bars assembled longitudinally and transversely to a conventional screen deck.

The upper edges of the longitudinal and transverse members have reentrant-section grooves into which corresponding beads of adjacent unreinforced screen panels are inserted and retained thereby. This construction has the advantage that the screen panels are readily replaceable, the worn panels are recyclable, and the screen assembly in use presents an uninterrupted, flat screen surface. The disadvantages are that the screen panels are necessarily small since the span of the flexible polyurethane material comprising the screen panel must be controlled to prevent undue distortion by flexing in use, at reasonable web thicknesses. The smallness of the panels with their peripheral mounting portions reduces the effective screen area. The supporting grid of longitudinal and transverse members is a complicated arrangement of interlocking steel cored polyurethane pieces. The arrangement is accordingly difficult to mount and dismount.

There are other screening members formed of polyurethanes without reinforcing, and thus are cheaper and more easily recyclable than reinforced screens. In Australian patent specification AU-A-19011/97 (LETELLA) there is provided a modular arrangement whereby a rigid, supporting reinforced polyurethane frame member is adapted to support an unreinforced polyurethane screen panel of large size by virtue of having intermediate support portions. The screen panels are moulded having a peripheral bead adapted to engage with peripheral grooves in the side edges of the frame members to secure the panels thereon. The end portions of the panels and frames overlying the standard-pitch (24" or approximately) screen deck support bars are adapted to be engaged by and secured to the deck support bars by a lower, bolted- down portion adapted to receive the frame and panel ends, and a locking piece overlaying the panel end edges and engaging the bolted down portion.

This arrangement goes some way to overcoming the disadvantages of the FIORIS apparatus. However, the screening panel is only retained against downward flexing on the intermediate support bar. In practice the screening panels that allow the screening web to impact on the intermediate support tend to suffer from impact tearing of the screening panels that gives the appearance of a cut failure. Polyurethanes are resistant to abrasion wear but are susceptible to cut damage. The screening panels reach sufficient amplitude in upward vibration to cause some loss of grade control in screening. The securing means intrudes onto the plane of the

screening surface thus tending to interrupt free flow of particles across the screening surface.

According to one aspect of the invention provides screening module for a vibratory screen deck including a screen support member releasably securable to said screen deck and having a peripheral frame and an intermediate strut therewithin, and a polymeric screen member releasably engaged by snap-in connection with each of said peripheral frame portion and said intermediate strut, said intermediate strut being located whereby flex of said polymeric screen member is controlled.

The screen support member may be of any suitably rigid construction material. For example, the screen support member may be formed of metal or rigid plastic. The screen support member may include an integral or assembled construction of supporting frame and intermediate strut. The screen support member may for example include an integral supporting frame to which is assembled the intermediate strut. By this means the strut may be selectably located within the frame. Alternatively the screen support member may include an integral rigid metal frame and intermediate strut. Preferably, the screen support member is of moulded polyurethane or other plastics construction and including an integral stiffening frame and intermediate strut core of rigid construction.

The screen support member may be configured whereby the length thereof is selected to span adjacent rails of a conventional screening deck. Alternatively, the screen support members may be adapted to span 3 or more support rails, or may be adapted to interconnect in spanning a pair of support rails. The screen support member may be of width selected to span the length of the screen deck support rails. However, it is preferred that the screen support members be of a manageable size and to this end the screen support members may be arrayed in multiples across the screen deck.

The screen support frame may be secured to the screen deck by any suitable means. For example, the screen support frame may be provided with engagement means adapted to engage complementary engagement means provided on the screen deck support rails. The engagement means may take the form of a bolt or stud on either of the screen support frame or the supporting rail and adapted to pass into a hole for securing with a nut, or a captive nut as the case may be, on the other.

However, it is preferred that the screen support frame be secured to the support framed by means selected to provide both intimate attachment of the screen support frame to the supporting rails as well as interconnection between adjacent modules on the screen deck.

In the preferred construction where the screen support frames span between adjacent screen deck support rails, the ends of the screen support frames may for example be provided with end portions specifically configured to accept fastenings that interconnect adjacent screen support frames as well as securing the adjacent screen support frames together, as described hereinafter with reference to modular screens generally. However the assembled screening modules may be secured to the screen deck, it is preferred that the securing means be selected whereby the securing means does not extend above the surface of the screening panels, whereby an uninterrupted screening surface may be maintained. It is also preferred that the securing means be installed before the screening panels are installed on the screen support members whereby the screen panels may overlie the securing means.

The intermediate strut may take the form of one or more strut portions extending from the periphery of the screen support member, whereby the maximum unsupported span of the screen panel is reduced to control screening grade. For example, the intermediate strut may take the form of an orthogonal array of strut portions disposed between the opposed sides and opposed ends of the screen support member to reduce the open area of the support member to panes. Alternatively, the intermediate strut may form other arrays such as an X-shaped array arising from the corners of the peripheral frame, or an annulus supported within the peripheral frame by radial strut portions.

In order to provide adequate support for the periphery of the screening panel as well as to maximize the effective open area the intermediate strut may be of lesser plan cross-section than the necessary cross-section of the peripheral frame or other frame element necessary to support the periphery of the screen panel. For example, the plan cross section of the intermediate strut may be of the minimum dimension required to accommodate the snap-in connection. The intermediate strut may also be interrupted to minimize the presented area.

In the preferred form of the apparatus where the screen support member spans adjacent screen deck support rails, the screen support may be relatively

longer than it is wide. In such embodiments the screen support frame may be configured to accept two or more screen panels. For example, the screen panels may be selected to have square symmetry whereby the panel may be inserted in selected orientations. Accordingly the screen support member may be provided with a transverse screen panel mounting portion effectively dividing the screen support frame into the necessary peripheral support configuration for use with multiple screen panels. Preferably, the screen support frame is configured to accept two square screen panels.

The screen panels may be of any suitable resilient material selected to exhibit the resistance to abrasive wear characteristic of polyurethane screening panels. For example the screen panels may be moulded from polyurethane. Since it is an advantage to be able to recycle the worn screen panels, it may be preferable to mould the screen panels from polyurethane alone. however, recyclability being a relative term, it may be possible or appropriate to provide the polyurethane screen with some form of reinforcing such as cord reinforcing or other material that may be co-processed with the polyurethane or steel wire reinforcing from which the bulk of the screen panel material may be readily stripped.

The screen panels are preferably sized to be flush-edged with the screen support member in use whereby the assembled screen modules formed therewith may in assembly on a screen deck present a continuous screening surface.

The snap-in connection may take any suitable form at least in part dictated by the nature of the selected screen support member and screen panel. The snap-in connection may comprise complementary snap-in components formed integrally with or assembled to the respective screen support member portions and the screen panels. Preferably, the snap-in components are integrally formed on their respective components. For example, in the case of all-metal screen support members the snap-in component may be inherent in the sections used in fabricating the member. Alternatively, in the case of the preferred metal-cored moulded polyurethane screen support members the snap-in component may be moulded into the polyurethane.

In the case of the snap-in component associated with the screen panel, it is preferred that this be integrally moulded in the formation of the screen panel. The snap-in connection is also preferably selected whereby the snap-in connection is universal for connecting the screen panel to the screen support member. By this

means it is not material whether a particular peripheral edge of the screen panel adjoins a peripheral edge of the screen support member or any intermediate support between screen panels.

The snap-in component on the screen support member may for example include an upstanding ridge extending about the periphery of a screen panel mounting portion of the screen support member the ridge having on its outward facing surface a peripheral groove. The corresponding snap-in component of the screen panel may for example comprise a reentrant channel having a ridge adapted to engage the groove on the screen support member when the channel is deformed thereover. The shape and dimensions of the respective ridges and channel are preferably selected such that any intermediate support portion of the screen support may accommodate the snap-in components of adjacent screening panels whereby the panels are retained in close mutual abutment. The peripheral snap-in components of one or more of the screening panel or screen support member may be continuous or may be interrupted.

The peripheral security of the snap-in connection may be enhanced by provision of a double-engaging snap-in connection. For example, the peripheral groove of the upstanding ridge may be supplemented by an undercut on the inner periphery of the upstanding ridge, whereby the reentrant channel may engage both the undercut and the peripheral groove.

The snap-in connection between the intermediate strut and the screen panel may take any suitable form. Since the role of the snap-in connection to the intermediate strut is one of preventing flex of the web of the screening panel rather than providing the peripheral support required by the panel as a whole, the snap-in connection may be by its nature similar to or different from the peripheral snap-in connection. Where the intermediate strut comprises an array extending across the span of the screen support member it may be desirable to interrupt the snap-in component of either the panel or the strut. The snap-in component associated with the screen panel is preferably selected whereby the screening are occluded thereby does not substantially extend beyond the area occluded by the plan section of the intermediate strut itself.

Similarly, the snap-in connection of the periphery of the screen panel to the screen support peripheral and intermediate (if any) portions similarly does not substantially occlude the openings available for screening through the screen support member. In practice, effective screening area of better that 75% of the total area of the screen modules has been achieved by use of apparatus in accordance with the present invention.

In another aspect this invention resides in a method of mounting screening modules to a support rail of a screen deck including the steps of:-

providing the screening module with an end portion adapted to overlie a support rail of a screening deck and having a recess formed therein defining a shoulder, said shoulder having a locating groove;

abutting said module recess-to-recess with an adjacent module on said support rail;

inserting into said recess a collet adapted to coact with said locating groove and the corresponding locating groove of the adjacent screening module to locate said screening modules in abutment; and

fastening said modules with fastening means adapted to cooperate with said collet to secure said modules to the support rail.

In a yet further aspect this invention resides in a screening module including:-

an end portion adapted to overlie a support rail of a screening deck;

a recess formed in said end portion and defining a shoulder;

a locating groove formed on said shoulder;

a collet adapted to coact with said locating groove and the corresponding locating groove of an adjacent screening module to locate said screening modules in abutment; and

fastening means adapted to cooperate with said collet to secure said modules to the support rail.

In the foregoing apparatus and method, the end portion may be adapted to overlie the support rail by any suitable means which will be at least in part dictated by the nature of the support rails. In the usual case, the support rails comprise a flat mating surface which is stiffened by virtue of being formed from one flat of metal angle stock. Accordingly, the end portion is preferably formed having a flat lower mating surface. Since the support rails have a width that occludes a portion of the

screening area, it is preferred that the end portions do not excessively further occlude the available screening area. In metal framed or metal cored polyurethane screen modules, the end portions may be formed of or incorporate a metal angle section whereas the remainder of the frame or core may be flat bar. The use of angle in the end portions tends to stiffen the structure at its ends where vibrating loads are applied by the screen deck.

The recess may be formed by any suitable means dictated by the nature of the end portion. For example in the case of metal cored polyurethane screen modules, the recess may be wholly formed in the polyurethane or the core may be modified in its fabrication to accommodate the recess formed in the polyurethane. The recess may be of any shape consistent with producing the aforesaid shoulder. Preferably, the recess is of sufficient depth to accommodate the fastening means whereby in use the fastening is wholly located beneath the screen surface.

The locating groove is preferably in the form of a chordal or arcuate groove in the shoulder, the line or apex respectively of which is disposed to the side of the fastening away from the abutment with the adjacent panel. For ease of formation, installation of fastening, reduction in area and length and direction of locating action, it is preferred that the recess be substantially semicircular in plan and that the locating groove comprise an arcuate groove substantially coaxial with the recess.

The locating groove may be of any suitable section consistent with engagement by a collet to locate the screen module in abutment with an adjacent screen module. For example, the groove may be of rectilinear section, part-round section or the like. Advantageously the groove is of a section whereby mutual engagement of the collet with the grooves of the adjacent modules serves to urge the modules into abutment and alignment. For example, the preferred arcuate groove may be provided with at least one ramped face against which the collet may act to provide alignment and abutment of the modules.

In a yet further aspect this invention resides in screening apparatus including a screen deck and a plurality of abutting screening modules in removable attachment therewith to form a substantially contiguous screening surface, each said screening module including a screen support member having a peripheral frame and an intermediate strut therewithin, and a polymeric screen member releasably engaged by snap-in connection with each of said peripheral frame portion and said

intermediate strut, said intermediate strut being located whereby flex of said polymeric screen member is controlled, said removable attachment including an end portion of said screen support member adapted to overlie a support rail of said screening deck, a recess formed in said end portion and defining a shoulder, a locating groove formed on said shoulder, a collet adapted to coact with said locating groove and the corresponding locating groove of an adjacent screening module to locate said screening modules in abutment, and fastening means adapted to cooperate with said collet to secure said modules to the support rail.

Preferred embodiments of the invention are described hereinafter with reference to the accompanying drawings wherein:

Fig 1 is a section through the general arrangement of the present invention;

Fig 2 is a perspective view of a screen support member of the apparatus of Fig 1;

Fig 3 is a perspective view of the reinforcing frame of the screen support member of Fig 2;

Fig 4 is a vertical section through a screening panel suitable for use in the apparatus of Fig 1;

Fig 5 is a side view of the screening panel of Fig 4;

Fig 6 is an alternate vertical section through the screening panel of Fig 4;

Fig 7 is a peripheral edge detail in section of the screening panel of Fig 4;

Fig 8 is detail view of a vertical section through the strut engaging snap-in portion of the screening panel of Fig 4;

Fig 9 is a cut-away plan view of the screening panel of Fig 4;

Fig 10 is a section through the screen deck mounting arrangement of the general arrangement of Fig 1; and

Fig 11 is a section through a collet suitable for use in the mounting arrangement of Fig 10.

In the general arrangement of Fig 1 there is provided a screening module indicated generally as 10 and comprising a screen support member 11 adapted to support a pair of screen panels 12. The screen support member 11 is of a length adapted to span between centres of support rails 13 of a screen deck.

In the view shown the screening module 10 is illustrated in half section at the right hand end of the figure and in side view in the left hand end of the figure. Referring to the sectioned portion of the figure, there are illustrated particular constructional features of the screen support member 11 which features may also be determined with reference to Figs 2 and 3.

The screen support member 11 comprises a fabricated stainless steel frame 14 having right angle section end portions 15 interconnected at their ends by welded on peripheral stringers 16. The peripheral stringers are interconnected at their mid-point by a transverse intermediate frame member 17. The end-portions 15 are interconnected at their mid-points by an intermediate stringer 18 which is slotted and welded to accept a similar treatment on the transverse intermediate frame member 17. The peripheral stringer 16 transverse intermediate frame member 17 and intermediate stringer 18 are of flat bar section of the same width, the end portions 15 are of lesser width in the same direction than the aforementioned stringers and frame members for reasons that will become apparent hereinafter. Each of the pains defined by the end portions 15, peripheral stringers 16 and transverse intermediate frame members 17 are bisected transversely by transverse webs 20 of the same width in section as the corresponding dimension of the right angle section end portions 15. The intermediate stringer 18 is relieved at points 21 flush with the right angled section end portions 15 and is further relieved at 22, the relief points 21 and 22 being made for reasons that will become apparent hereinafter.

The end portions 15 are each provided with a pair of partial cut-outs at 23 into which are welded semi-circular wall portions 24. A lip 25 is left standing in the cut-out 23. A semi-circular slot 26 is milled vertically through to the bottom face of the end-portion to provide a fixing aperture to the support rails 13.

Polyurethane is moulded over the stainless steel frame 14 generally as illustrated in Fig 2 to form the screen support member 11. Moulded end portions 27 include a sloping faced portion 30 filling in the angle of the end portions 15 and thus preventing accumulation of material thereon. The moulded end portions 27 are also specially moulded at the partial cut-outs 23

whereby the semi-circular slots 26 and the semi-circular wall portions 24 remain open whilst the lip is substantially embedded.

As best illustrated in Fig 10, the semi-circular wall portion 24 is thinly embedded in polyurethane 21 and a floor 32 is formed within the recess defined by the semi-circular wall portions 24. The floor 32 is provided with an arcuate V-section groove 33.

The polyurethane moulding forming the outer surface of the screen support member 11 is moulded to the same horizontal plane irrespective of the respective widths of stock used to construct the stainless steel frame 14. At the upper peripheral edge of the screen support member 11 is moulded a peripheral screen panel engagement bead 34 which is discontinuous at the partial cut-out 23 and at the ends of the intermediate member 35 which is moulded over the transverse intermediate frame member 17. This latter interruption allows for intermediate screen engagement beads 36 to provide discrete mounting for respective screen panels 12 in side by side relation on the screen support member 11. The polyurethane moulding over intermediate stringer 18 and transverse webs 20 are similarly provided with screen panel web engagement beads 37.

The screen panels 12 are integrally moulded in polyurethane and include a peripheral mounting portion 40 defining the square plan of the screening panel 12, the peripheral mounting portions 40 being adapted to overlie the screen panel engagement bead 34 and the intermediate screen engagement beads 36. Intermediate mounting portions 41 divides the area of the screen panels 12 into four square panes 42, the intermediate mounting portions 41 being adapted to overlie the screen panel web engagement beads 37.

~~The peripheral mounting portion 40 defines a peripheral channel 43~~ best illustrated in Fig 7 and described hereinafter in conjunction with the form of the screen panel engagement bead 34 ~~and~~ intermediate screen engagement beads 36. As illustrated in Fig 10, the beads 34, 36 have a crown 44 and inner wall 45 defining the bead body, the crown 44 being provided at its outer edge a bead 46 adapted to extend laterally out of the plain ~~of the screen panel 12 in use. The peripheral channel 43 of the screen~~

panels 12 are provided with an inwardly directed lateral bead 47 whereby downward pressure on the panel effects passage of the bead 47 over the bead 46 to effect partial engagement of the screen panel 12 with the screen panel engagement beads 34 and intermediate screen engagement beads 36. The inner wall 45 has a lower edge terminated by an undercut 50. The peripheral channel is bounded at the lower edge of its inner wall by a corresponding protuberant portion 51 whereby defamation of the peripheral channel 43 on downward pressure on the peripheral mounting portions 40 causes the protuberant portion 51 to enter and engage with the undercut 50. By this means, the peripheral channel 43 effectively serves to double lock the screen panels 12 to the screen support member 11 against dislodgment vertically out of the plane of the screen deck.

The intermediate mounting portions 41 include discrete web engagement portions 52 defining a mushroom section channel 53 adapted for snap-in engagement with a corresponding mushroom section bead 54 comprising the upper portion of the screen panel web engagement beads 37. By this arrangement, the transverse plan dimension of the screen panel engagement beads 37 and the moulded dimension over the intermediate stringer 18 and transverse webs 20 may be reduced to maximise effective screen area.

Apparatus in accordance with the foregoing embodiment comprising 609.6mm x 304.8mm screening modules 10 enables a screening effective surface area of better than 75% of the total screening module area.

The screen panels 12 have a slotted screening surface 55 with rows of slots divided on the underside and reinforced by integral polyurethane moulded webs 56.

The interrupted nature of the mushroom section channels 53 ensures that the web of the screen panels 12 is adequately engaged against lifting under the inertia of the panel in use whilst preventing stress concentration at corners.

The screen modules 10 are secured in mutual abutting relation to the screen rails 13 by bolts 57 adapted to engage captive nuts 60 provided on the underside of the bearing surface webs of the support rails 13. When adjacent

screening modules 10 are laid up in abutting relation with their partial cutouts 23 aligned, the semi-circular slots 26 also align to provide a passage through which the bolt 57 may pass. Interposed under the head of the bolt is a collet 61 having a downwardly depending circular flange 62 having a V-section lower profile 63 adapted to cooperate with the respective arcuate grooves 33 in the floors 32 of the moulding. The tightening of the bolt 57 urges the collet 61 into engagement with the grooves 33 thereby urging the adjacent screening modules 10 into mutual abutment as well as clamping the screening modules 10 to the screen rails 13. A dust cap 64 is moulded of polyurethane and has a hex section recess 65, the dust cap 64 being adapted to engage the combined recesses of the adjacent screening modules 10 in close conformance therewith to seal the bolt head and threads against the ingress of fine particles which may otherwise seize the fixing. The dust cap 64 is adapted to reside in use below the subsequently installed screen panels 12.

Apparatus in accordance with the foregoing embodiment has the advantages that the screen panels are securely supported at their periphery and that the intermediate portion of the screen panels is adequately supported against excessive inertial flexing in use. The screen panels being integrally moulded of unreinforced polyurethane are recyclable without stripping. The screen modules span the support bars and are mutually secured by fixings that do not protrude above the screening surface, that function to urge the screening modules into tight abutment and which are protected from seizure. The number of fixings required for a screening deck is reduced by sharing of the fixings between modules thus speeding the process of mounting and dismounting the screening deck.

It will be appreciated that the above has been given by way of an illustrative example of this invention and that all such modifications and variations thereto as would be apparent to the person skilled in the art are deemed to fall within the broad scope and ambit of this invention as defined in the following claims.